

The Energy Efficiency Opportunity

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Advanced Technology Director, Intel Corporation
President, Climate Savers Computing Initiative

October 2007

IT Top Issues

My Business



Data Center



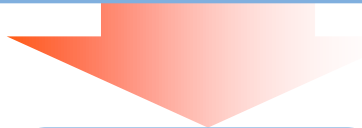
Factory/Warehouse



Office



Mobile Workforce



Security Threats
and Compliance

Increasing
Complexity & TCO

Productivity
Barrier

Environmental
Imperatives

Information
Explosion

Building and Retaining
Business Skills

Improving
Business Processes

Environmental Imperatives



Intel's Approach to Eco-Technology



Sustainable
Manufacturing



Energy Efficient
Performance



Policy &
Industry



E-Waste
Initiatives

Intel's Approach to Eco-Technology

**Sustainable
Manufacturing**



A History of Environmental Consciousness

Beginning with Intel co-founder Gordon Moore...

- U.S. Chamber of Commerce Business Civic Leadership Center's 2006 Corporate Stewardship Award

Recognizing decades-long commitment to education, community development, and sustainable environmental practices

- In 2005 Intel began to publicly report our environmental, health and safety indicators

Providing timely information about our emissions, resource usage and waste generation



Operations: Environmental Responsibility

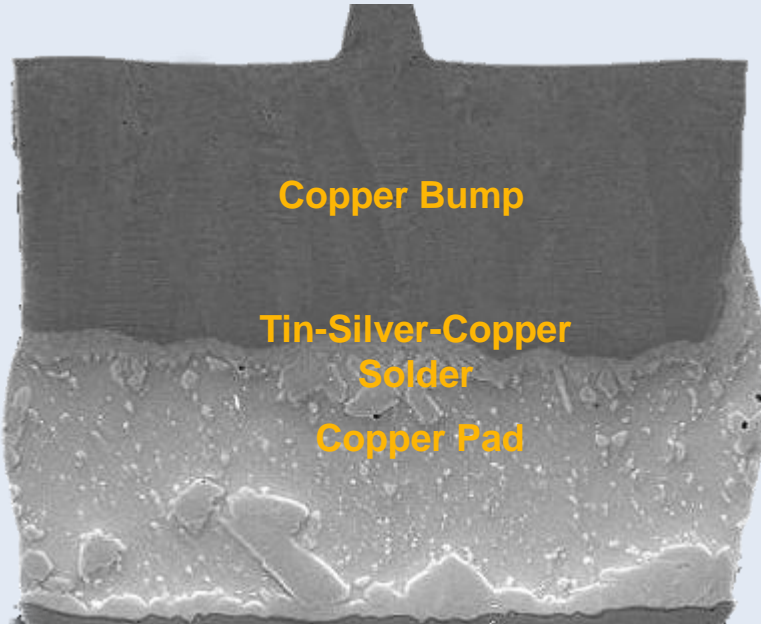
- Reduce greenhouse gas emissions per production unit 50% below 2002 baseline by 2010*
- Reduced energy consumption in our operations*
 - Reduced energy consumption in our operations 20% per production unit over the last three years
- Remove hazardous materials from our products
- Recycle 74% of our solid waste and 68% of our chemical waste in 2006*

*Source: Intel 2006 Corporate Responsibility Report



Packaging Innovations

100%
Lead Free Technology



60%
**Smaller Packaging for
New Market Segments**



All 45nm CPUs Will be Halogen Free in 2008



Intel's Approach to Eco-Technology

**Energy Efficient
Performance**



Intel's Design & Process Cadence to Maintain Product Leadership

2 YEARS

Shrink/Derivative
XPF 5000 Series

New Microarchitecture
Core 2 Duo • XPF 5100/5300 Series



65nm

2 YEARS

Shrink/Derivative
XPF 5400 Series

New Microarchitecture
NEHALEM



45nm

2 YEARS

Shrink/Derivative
WESTMERE

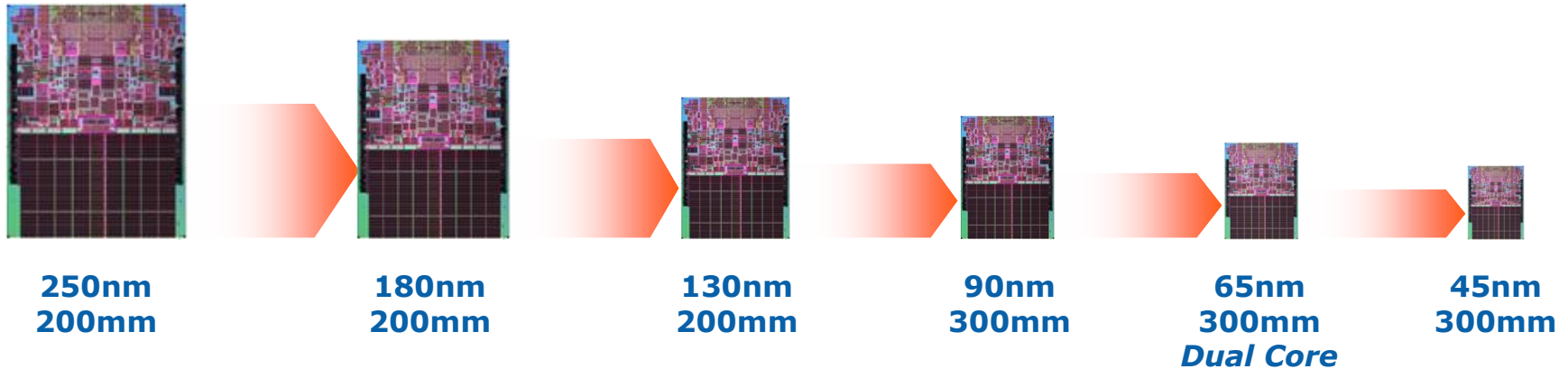
New Microarchitecture
SANDY BRIDGE



32nm



Relentless Pursuit of Moore's Law Opens the Door to Innovation



Industry's 1st 45nm High-K Process Technology

~**2x** Improvement In Transistor Density

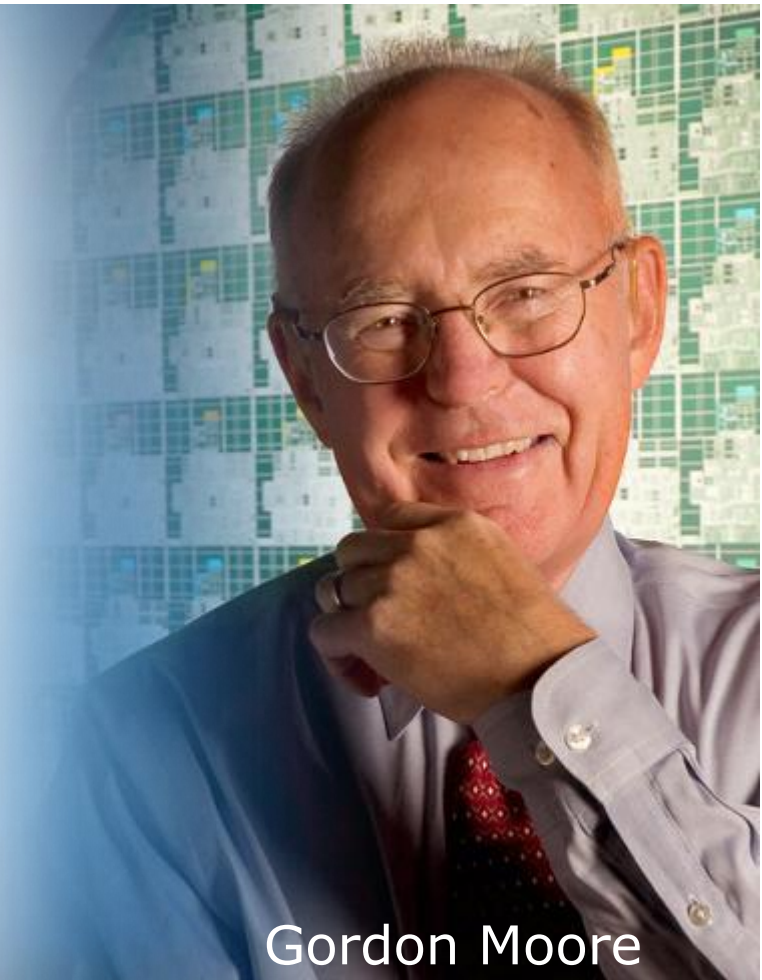
>**20%** Improvement In Transistor Switching Speed

~**30%** Reduction In Transistor Switching Power

Industry-Changing Innovation

“The implementation of high-k and metal materials marks the biggest change in transistor technology since the introduction of polysilicon gate MOS transistors in the late 1960s.”

– *Gordon Moore*



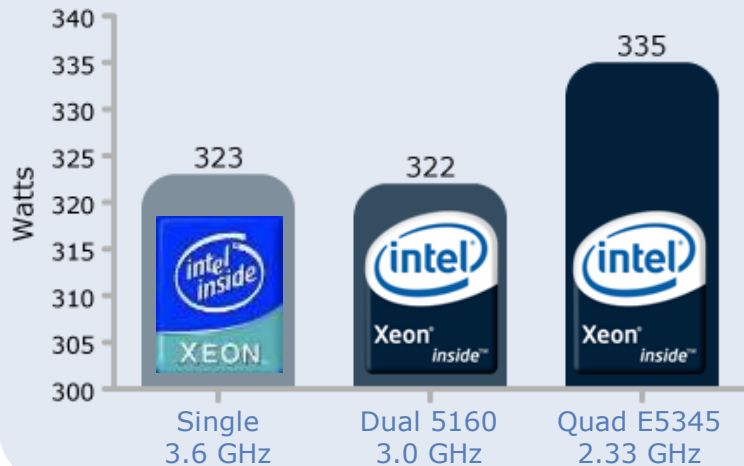
Gordon Moore



Multi-Core Power Efficiency

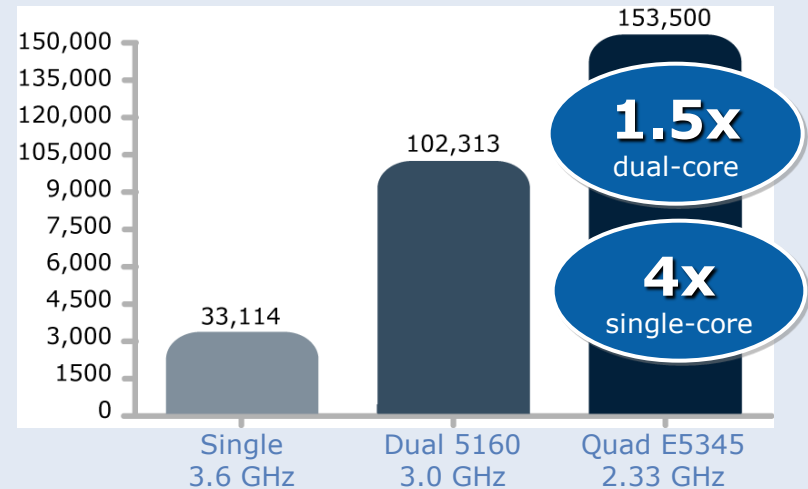
System Power

Lower is better



Performance

SPECjbb2005 - Higher is better



- Same Power Envelope
- Outstanding Performance per Watt
- Socket & Platform Compatible
- Mainstream parts at 80W, Low Voltage at 50W
- Intel® Core™ Micro-architecture

www.intelstartyourengines.com

Enabling Datacenter Optimization Intel Approach to Energy Efficiency

Time/Sophistication



Lower Power Components

- Core μ Arch
- Quad-Core to 80W
- LV to 50W



Increasing Efficiency

- Virtualization
- Accelerate refresh
- DBS



Rack Optimization

- Monitored power
- Optimization tool
- Set power limits



Power Management

- VM balancing
- Rules based load balancing
- 20+ kW/rack

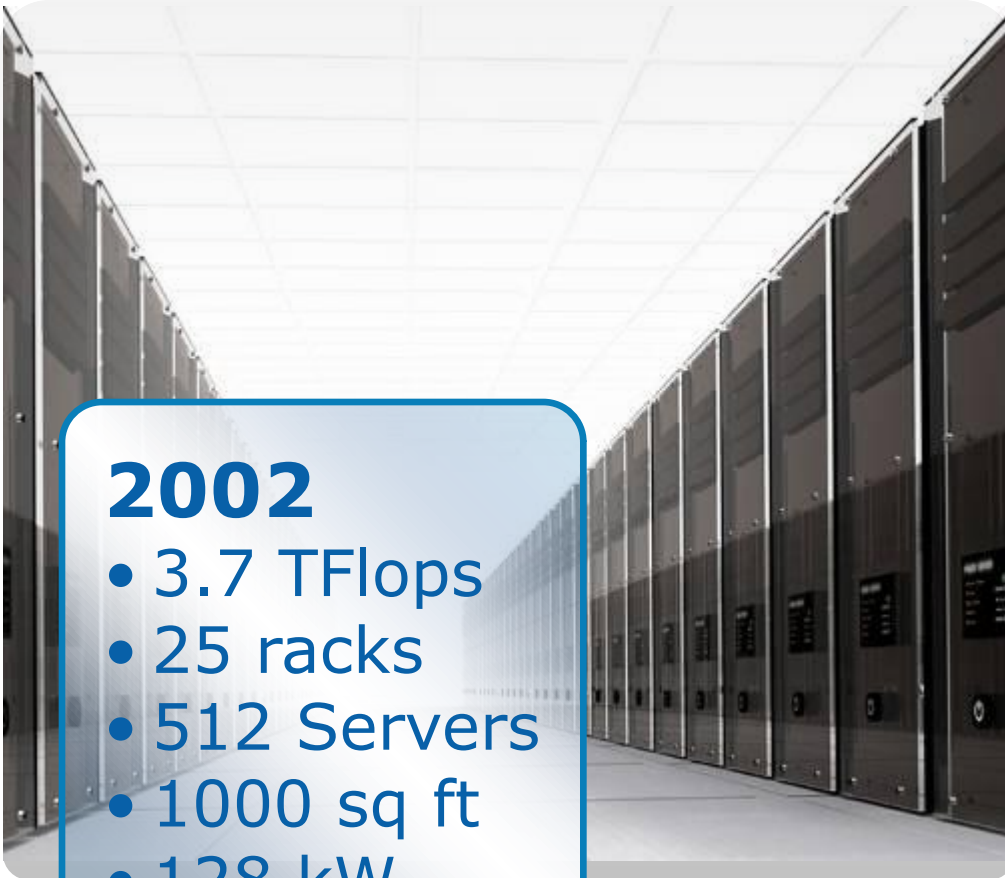


Industry Involvement

- Enabling the Industry to meet the EPA's Energy Star Specification
- PG&E Rebate program for Virtualization
- Active engagement in PMbus Implementers Forum

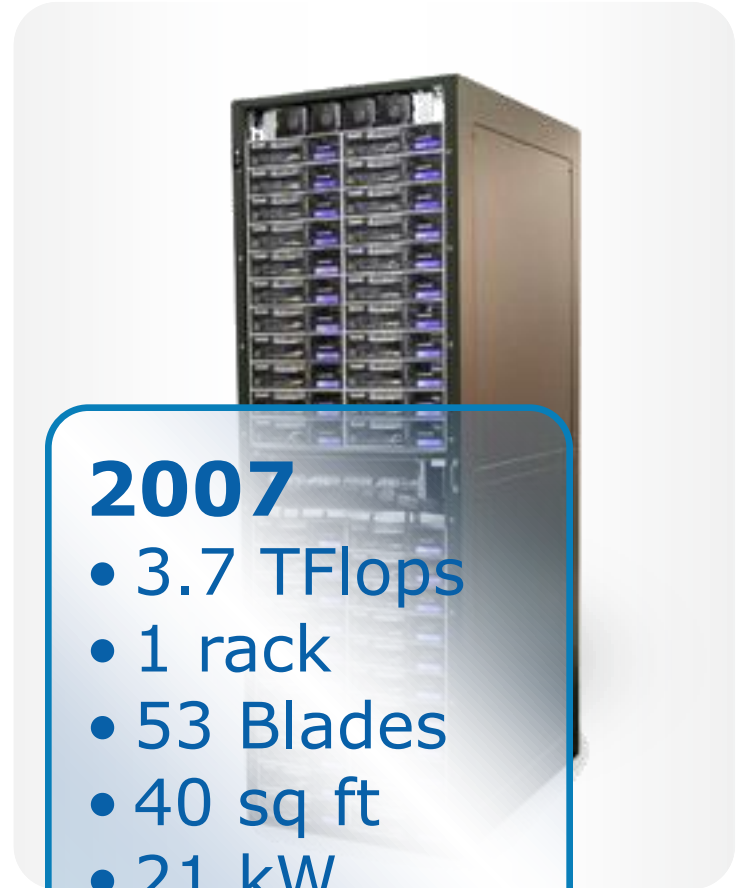


Moore's Law: Delivering Data Center Optimization



2002

- 3.7 TFlops
- 25 racks
- 512 Servers
- 1000 sq ft
- 128 kW

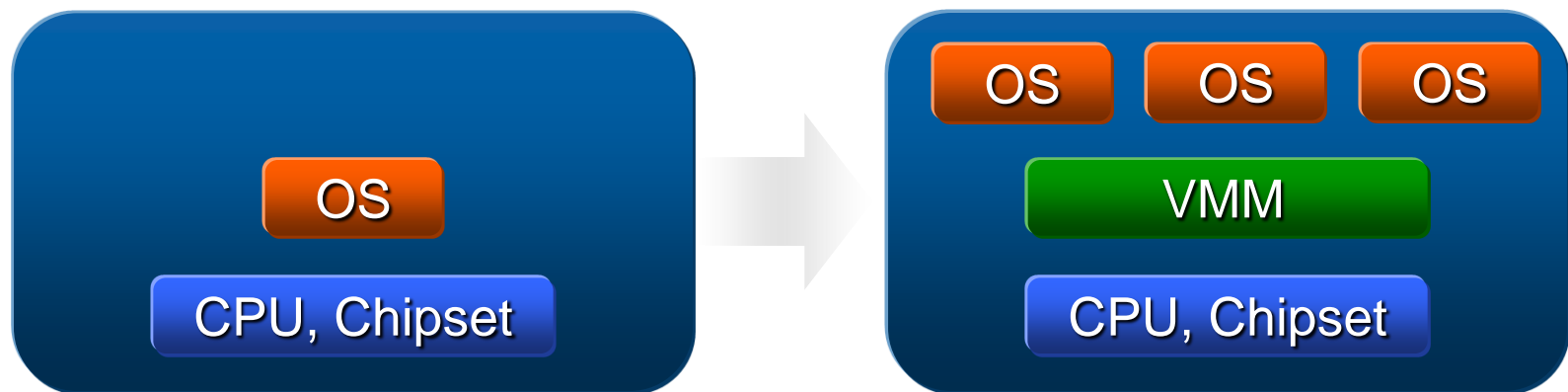


2007

- 3.7 TFlops
- 1 rack
- 53 Blades
- 40 sq ft
- 21 kW

Datacenter Energy Efficiency

The Virtualization Opportunity



Single OS

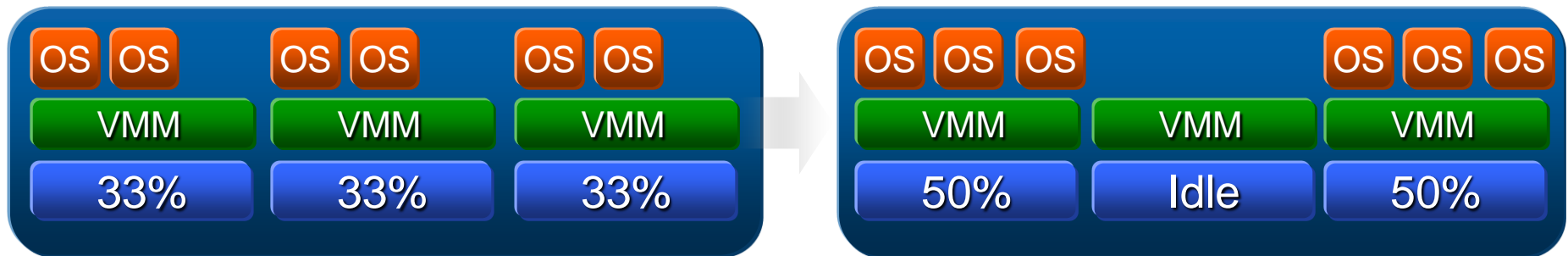
Rich Power Management in CPU
C and P States Managed by OS

Optimization for Multiple OS
Rich Power Management in
CPU

C and P States Managed by the
VMM

Node Level Energy Management Through VMM

Datacenter-wide Energy Efficiency



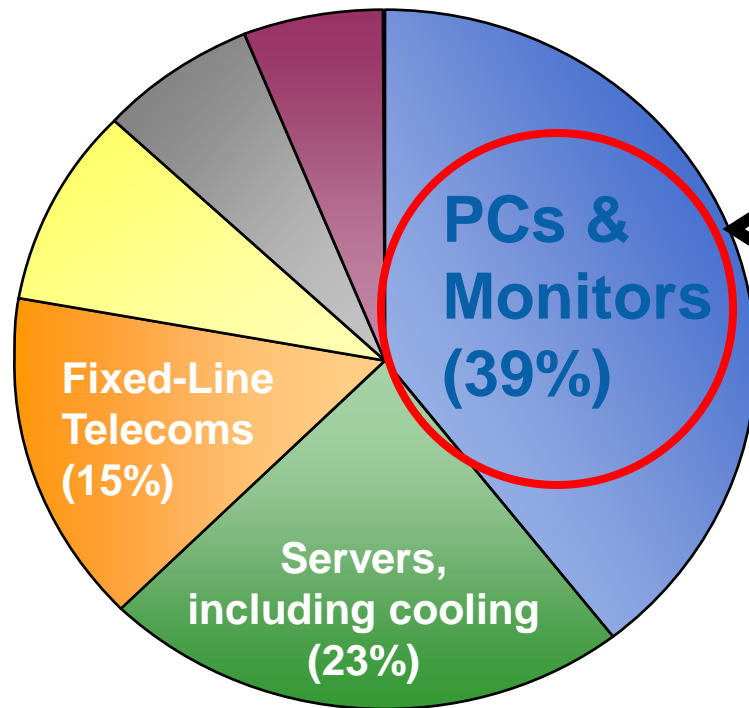
Global Optimizations
VM Migration to Consolidate Load
Put Idle Nodes in Lower Power State

	Clock Speed	TDP	Old Idle Power	New Idle Power
Intel® Xeon 5355 (Quad Core)	2.66 GHz	120W	50W	25W
Intel® Xeon 5150 (Dual Core)	2.66 GHz	65W	24W	8W

Energy Efficiency Across Variable Loads in datacenter OS



PC Energy Consumption is Important



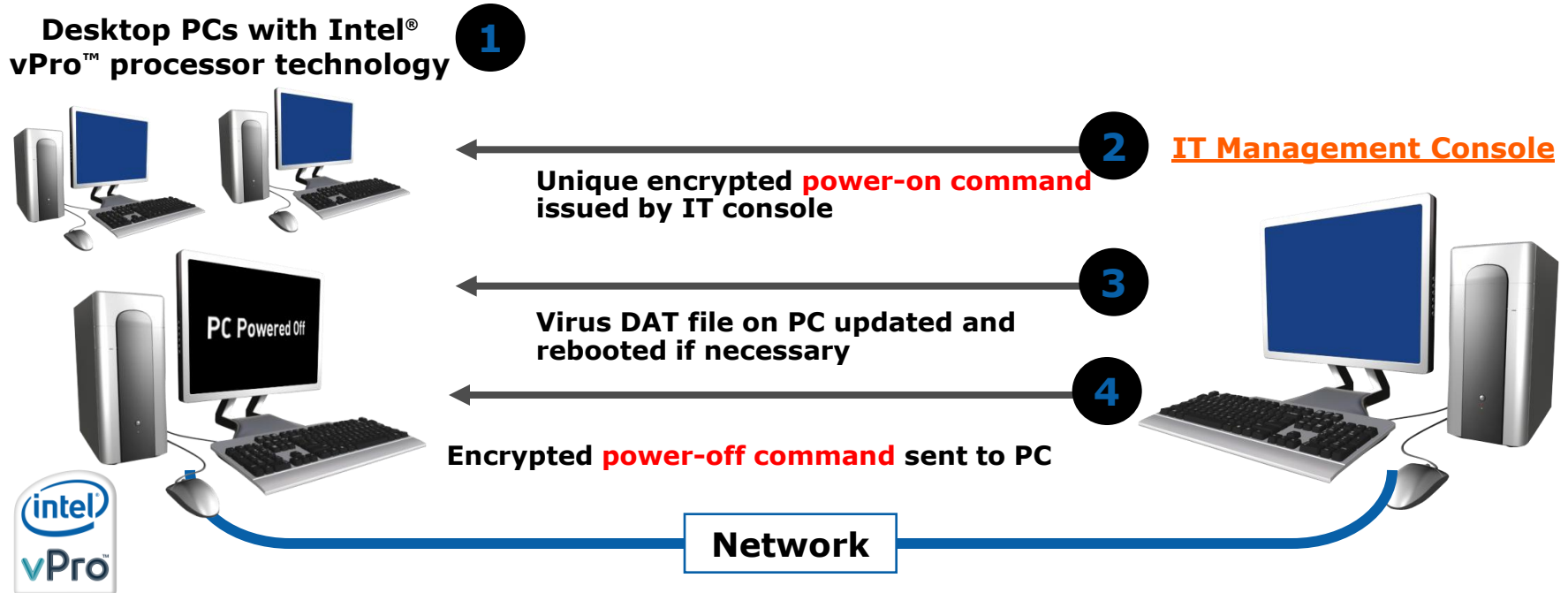
"Data centers receive a lot of attention because they are an obvious concentration."

"However, the real area where the greatest overall effect can be made is at the desktop and with client devices."¹

1) Source Gartner Inc. "Tera-Architectures A Convergence of New Technologies" by Martin Reynolds July 26, 2007

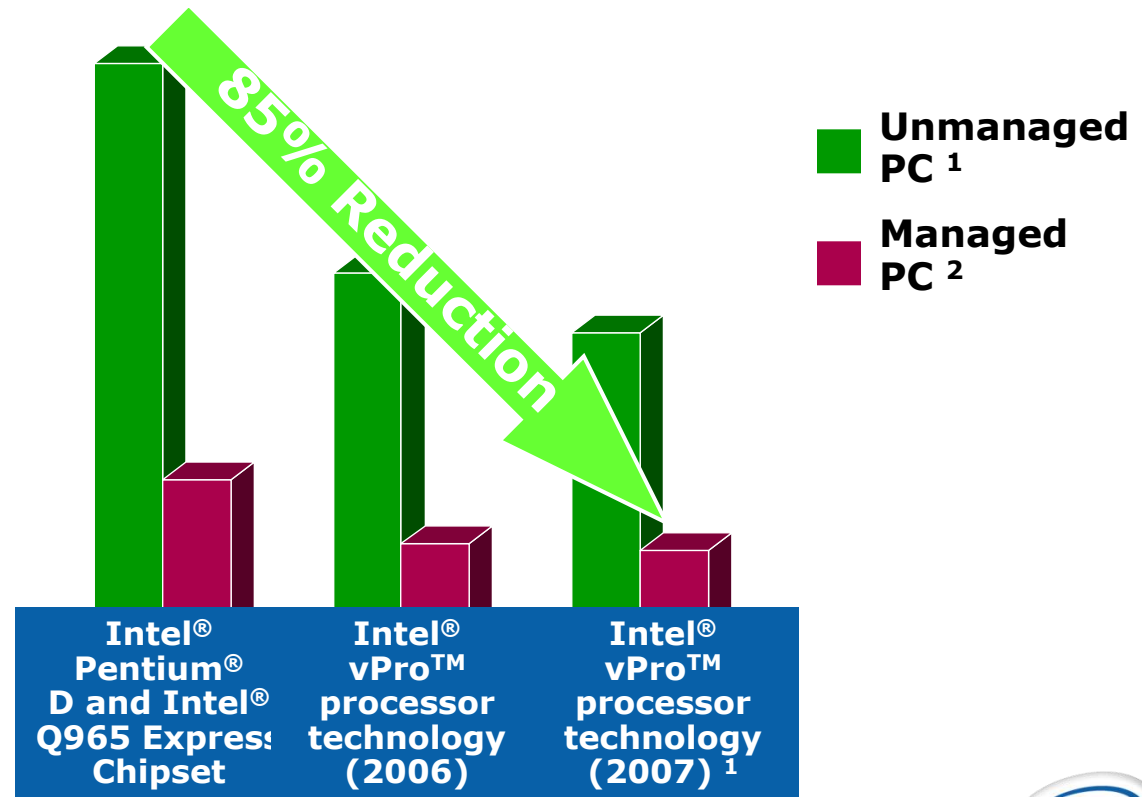
More Manageable PCs Help Reduce Power Consumption

Manage and protect PCs, even when they are powered off, with Intel® vPro™ processor technology



Intel® vPro™ processor technology (2007)

A well managed PC with Intel® vPro™ processor technology (2007) and the Intel® Core 2 Duo processor delivers clear performance leadership while costing as little as \$10 per year* for energy



Performance tests and ratings are measured using specific systems and/or components and reflect approximate performance of Intel products as measured by those tests. Any difference in system hardware, software, or configuration may affect actual performance. Buyers should consult other sources of information to evaluate system or component performance they are considering purchasing. For information on performance tests and performance of Intel products, visit <http://www.intel.com/performance/resources/limits.htm>

1 7.765 cents/KWh, which is the U.S. average for industrial and commercial customers as of December, 2006. Source: U.S. Department of Energy



Power Savings: Siemens Study

Powers Savings and Intel® vPro™ processor technology

Darren Baker, Siemens IT Solutions and Services, Inc.

If a standard PC uses 160 Watts per hour and is on for 24 hours, it has used 3840 Watts or (3.9 kWh)

With Intel vPro processor technology, you can schedule the PCs to auto power off each night so they are only actually powered up for 16 hours. For example: Auto power on machines at 5am and power down at 10pm. This will provide a savings of 8hrs of power usage per day or the equivalent to 1.28 kWh per PC/per day.

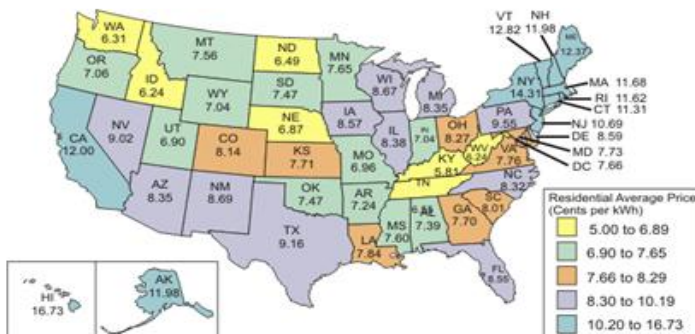
How is that significant?

In the state of NJ, the price of 1 kWh = .11 cents. If you have 5000 PCs, and you save 1/3 of the power costs or 1.28kWh per day for 365 days, you have saved 2800000 kWhs (or 2800 MWhs, or 2.8GWhs) (This is the equivalent of \$4.40 per pc/per month)

This one feature alone saves the company \$264,000 yearly.

Previously you had to leave the machines on at night if you had to perform maintenance, apply patches or anti-virus updates. With Intel vPro processor technology, the maintenance packages can wake the PC up even if it is off.

The \$52.80 savings per pc/year you save in power consumption alone pays for the cost of adding Intel® vPro™ processor technology.



Source: Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report."

Turn your PCs off at night and still keep strong security with Intel® vPro™ processor technology¹

"This one feature alone saves the company \$264,000 yearly [and] pays for the cost of adding Intel® vPro™ processor technology"²

²Source: Siemens IT Solutions and Services newsletter, 2007



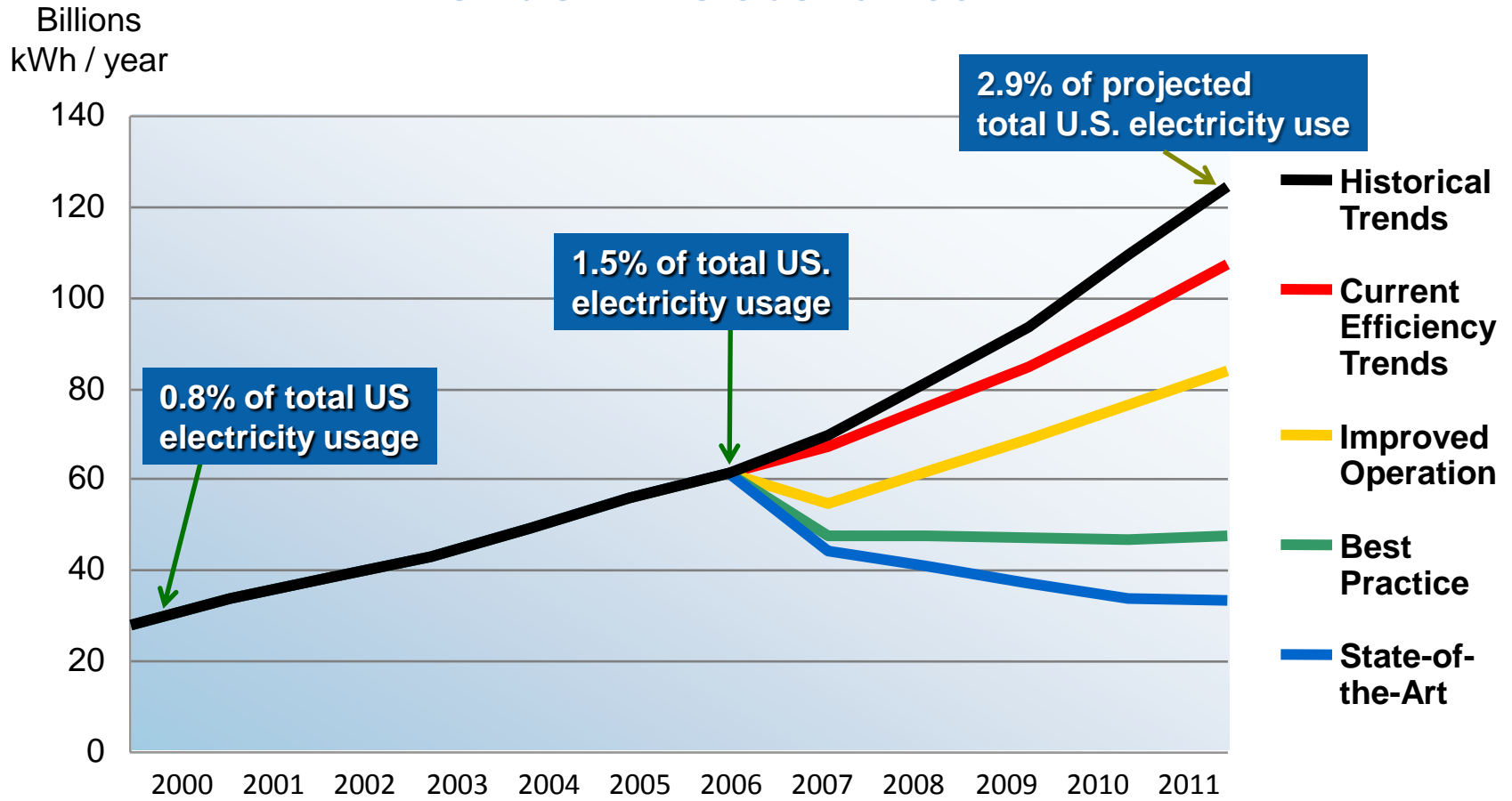
Intel's Approach to Eco-Technology

A close-up photograph showing two hands, one with a darker skin tone and one with a lighter skin tone, gently cupping a small, colorful globe of the Earth. The globe is centered on the Atlantic Ocean, showing parts of North and South America. The hands are wearing white long-sleeved shirts. The background is a soft, out-of-focus grey.

**Policy &
Industry**

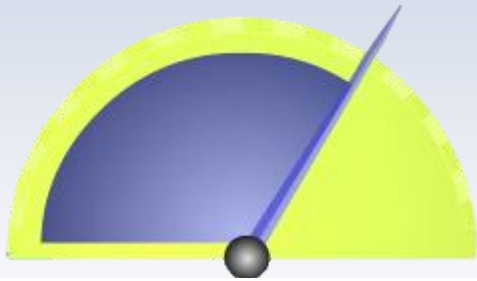
The EPA and Datacenter Efficiency

Projected Datacenter Energy Use Under Five Scenarios



EcoRack Results

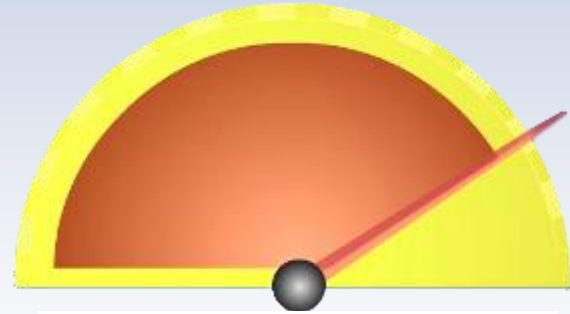
Eco Rack



10,000 W

Total Power

Standard Rack



12,303 W

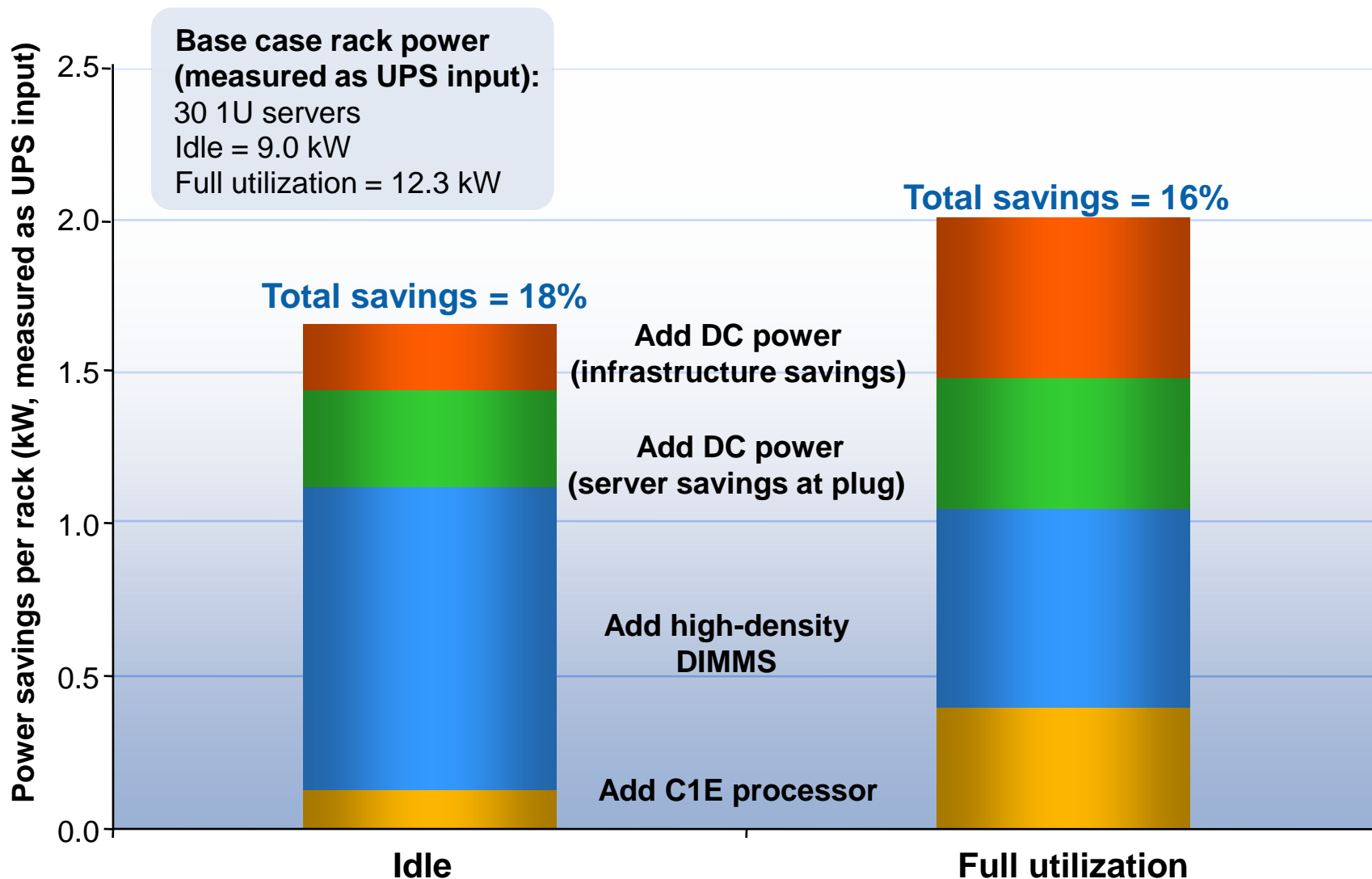
Total Power

**Up to 18% Power Savings at Equal
Acquisition Cost & Performance**

\$44, 314 Annual Cost Savings



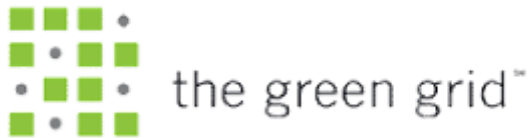
Sources of EcoRack 1 Savings



Data current as of September 18, 2007. Both Standard and Eco-Rack cases assume power save switch (SpeedStep) is on.



Our Policies and Initiatives: Advancing Global Sustainability



Other names and brands may be claimed as the property of others.





- Increase computing energy efficiency
- Increase use of power management
- **Reduce computer power consumption 50% by 2010.¹**

¹ Based on IDC projections of desktop and server units shipped, a baseline of typical desktop and server power consumption in the first half of 2007, and an average cost of \$0.0885/KW.



Energy Issues Facing IT Industry

- The global information and communications technology industry accounts for approximately **2% of global CO₂ emissions**.
- By 2009, US datacenters will house **50% more servers** than in 2007
- Energy costs – typically around 10% of an IT budget—could account for **50% of the average IT budget** in just a few years.¹
- “By 2010, about half of the Forbes Global 2000 companies will spend more on energy than on hardware such as servers.”¹



¹ Source: Gartner, May 2007

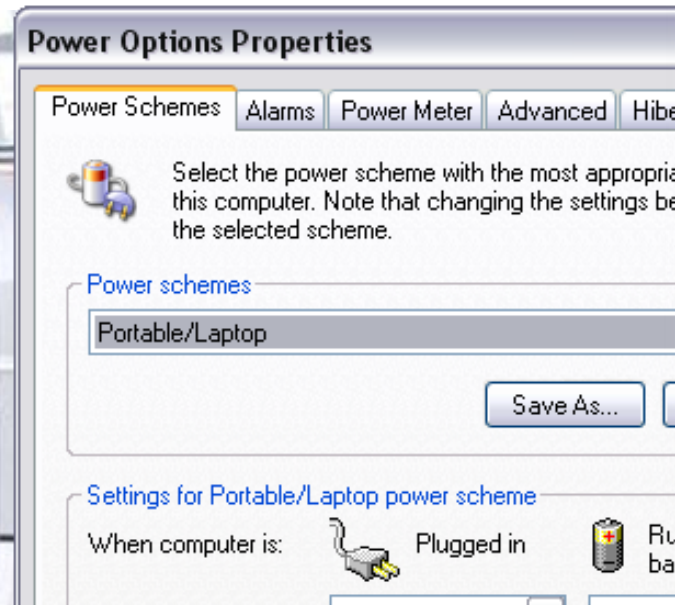
² Source: Businessweek.com: CEO Guide To Green Computing.

³ Based on IDC projections of desktop and server units shipped, a baseline of typical desktop and server power consumption in the first half of 2007, and an average cost of \$0.0885/KW.

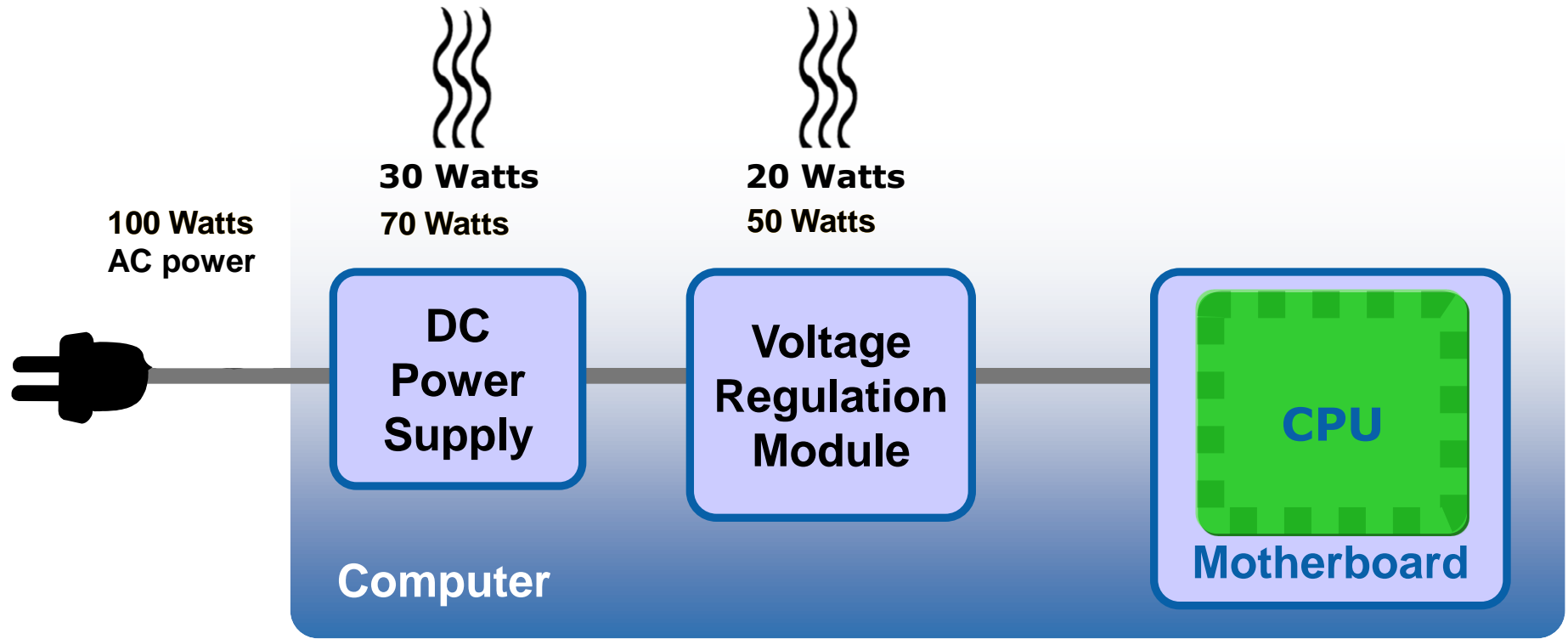


Today's Reality

- The average desktop PC wastes nearly half the power delivered
- Servers lose approximately one-third of their power
- 90% of desktops do not utilize power management settings



Power Conversion



Half of the power is lost as heat

Does an Efficient Computer Cost More?

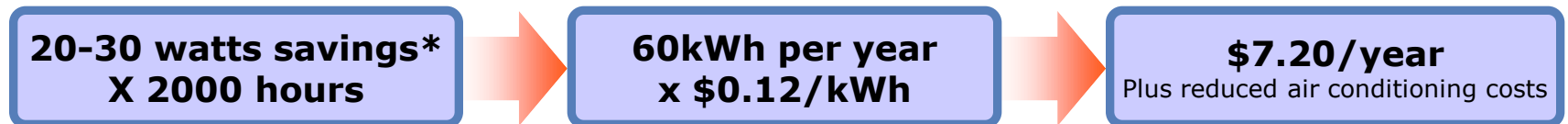
Initial Price Premium

(expected to drop to \$0 when in large-scale production)

Desktops: ~\$20 **Servers:** ~\$30

**Energy savings over first 1-2 years
will offset costs**

Estimated Desktop Savings



Utility rebates can
further offset costs

* Assumes system is powered on 2,000 hours per year (40 hrs/week X 50 weeks)



Collective Impact by 2010

- Goal is to improve computing energy efficiency by **50%**
 - Collectively **save \$5.5 billion** in energy costs
- Reduce global CO₂ emissions from computing platforms by **54 million tons** per year
 - Equivalent to **removal of 11 million autos**
 - **Eliminating 20 coal plants** from the planet
 - **Planting 25,000 sq. miles** (~65,000 km²) of trees



Intel is Walking the Talk

Intel is committed to the Climate Savers Computing Initiative



Climate Savers Computing Initiative Members





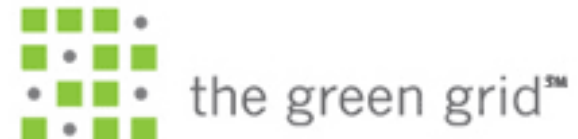
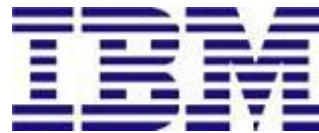
the green grid™

A global consortium dedicated to developing and promoting energy efficiency for data centers by:

- Defining meaningful, user-centric **models and metrics**
- Developing **standards, measurement methods, best practices** and **technologies** to improve performance against the defined metrics
- Promoting the **adoption of energy efficient standards**, processes, measurements and technologies



Board of Directors and Founding Member Companies



Technical Workgroups

Data collection and analysis

- Investigations and analysis into datacenter efficiency problem space

Datacenter technology and strategy

- Existing and emergent technologies for datacenter efficiency

Datacenter operations

- Use models, operational strategies and best practices
- Equipment standards

Datacenter metrics and measurements

- Datacenter characteristics and performance metrics
- Measurement protocols for data collection

Intel's Approach to Eco-Technology



**E-Waste
Initiatives**

Shared Responsibility

- Manufacturers, retailers, consumers, governments, and recyclers should share the responsibility for e-waste recycling and/or ultimate disposal
- We partner with Rethink, EPA, NGOs, OEMs and Retailers to help manage e-waste



Summary

Efficient IT provides bottom line benefits

Work with us to drive computing efficiency

- Join the Climate Savers Computing Initiative
 - Deploy power management!
- Migrate legacy systems to efficient alternatives
- Consider approaches for data center optimization
- Utilize e-waste program opportunities





Delivering Sustainability in Everything We Do

Our Products

- Energy-efficient performance

Our Operations

- Environmental responsibility

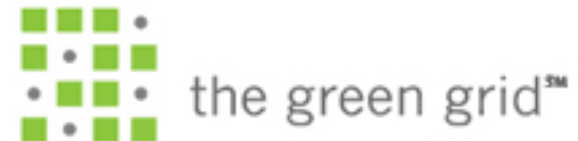
Our Policy and Initiatives

- Advancing global sustainability



What is The Green Grid Doing?

- Creating shared definitions, benchmarks and metrics to enable real-time measurement and control of datacenter efficiency and productivity
- Creating baseline 'state-of-the-industry' documentation including benchmark architectures and a repository of datacenter efficiency knowledge
- Creating a comprehensive technology roadmap for future datacenter design to maximize efficient and productive operations
- Assessing new and alternate datacenter technologies
- Monitoring progress on all fronts and providing periodic updates



Technical Roadmap

Data Collection

Standards and Metrics Inventory

Datacenter Metrics Development

Operationalizing Energy-Efficiency Data Collection

Data Assessment

Efficiency Baseline Study

Operational "Best Practices"

Database for Data Center Performance

Technology Proposals

Initial Technology Roadmap

Power Distribution Options Study

Cooling Options Study



the green grid™

Penryn

2nd Generation Quad Core

**Intel SSE4 instructions
Fast Super Shuffle Engine**

**Increased Performance
and Energy Efficiency**

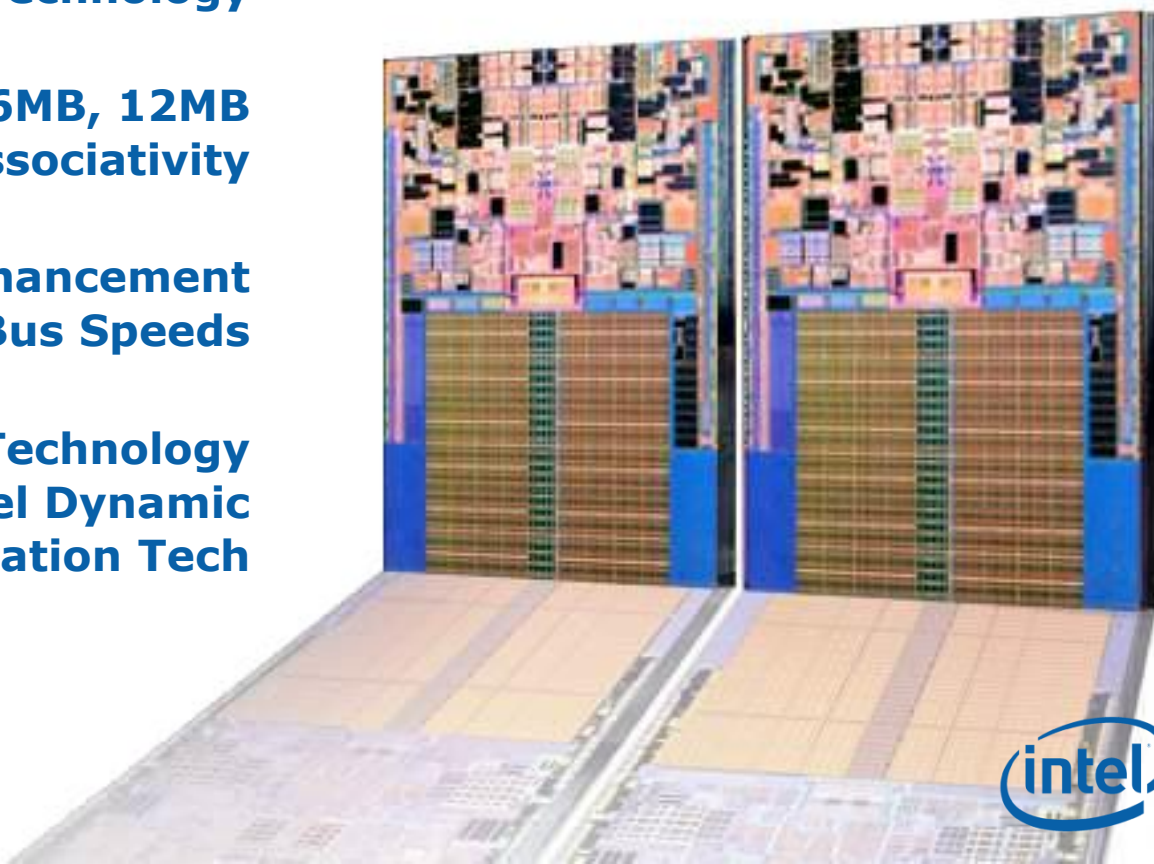
> 3 GHz

**Fast Radix-16 Divider Enhanced
Intel Virtualization Technology**

**Larger Caches: 6MB, 12MB
24-way Set Associativity**

**Split Load Cache Enhancement
Higher Bus Speeds**

**Deep Power Down Technology
Enhanced Intel Dynamic
Acceleration Tech**



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